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Marketing Research Division

Consumer Preferences for FROZEN PEAS in relation to STANDARDS FOR GRADES

MARKETING RESEARCH REPORT NO. 280

U. S. *Agricultural Marketing Service. Marketing Research Division.*

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PREFACE

This study was undertaken at the suggestion of F. L. Southerland of the Fruit and Vegetable Division, Agricultural Marketing Service, who, together with L. S. Fenn and A. E. Browne of the same Division, participated in the planning of the experiment. It is a part of a broad program of research aimed at improving marketing efficiency and expanding markets for farm products.

The study itself was conducted under the general supervision of Trienah Meyers of the Market Development Branch, Agricultural Marketing Service, and W. F. Talburt of the Western Utilization Research and Development Division, Agricultural Research Service.

The chemical and physical measurements were made by W. C. Dietrich, and the small panel discrimination and preference tests were made by M. M. Boggs, both of the Western Regional Laboratory. Data from the consumer preference experiment were analyzed by J. Scott Hunter of the Market Development Branch, who was also responsible for coordinating the separate phases of the study.

Field work on the consumer preference phase of the study was done under contract with the Department of Agriculture by National Analysts, Inc., of Philadelphia, Pa. Dr. James A. Bayton of that organization participated in planning the study, trained the field staff and reviewed the final draft of the report.

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HIGHLIGHTS

The purpose of this study was to investigate the relationship between consumer preferences and the standards for grades of frozen peas.

In order to characterize the peas used in the investigation, the chemical and physical measurements most commonly used as indices of quality were made. The results showed that the peas were properly classified by grade but that grade C peas were a mixture of rather immature and quite overmature peas rather than a homogeneous lot of the lowest grade.

In one phase of the study samples of the peas were tasted by a small panel of inexperienced tasters to determine whether or not the 3 grades were mutually discriminable. A significant proportion of these subjects were able to distinguish between all combinations of the 3 grades.

The panel also indicated its preferences as regards the separate quality factors: Flavor, tenderness, and color. All these factors of grade A were well liked and successively lower grades were progressively less well liked.

In another phase of the study ratings of the overall quality of each grade were obtained from a panel composed of adults living in private households. A random sample of 25 clusters of households in Oakland, Calif., was drawn and within each cluster 9 households were selected to participate in the consumer experiment. The peas were rated by all members of each household 16 years of age and over. Results show that consumers do discriminate between grades and prefer higher grades.

The mean preference score for grade A was 8.8, for grade B, 7.6, and for grade C, 7.2.

The 2 most important characteristics influencing favorable ratings for all grades were taste and tenderness. These characteristics were also the basis for the distinctions consumers made between grades; for other characteristics mentioned there was little difference between grades.

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CONSUMER PREFERENCES FOR FROZEN PEAS IN RELATION TO STANDARDS FOR GRADES

Market Development Branch
Agricultural Marketing Service

INTRODUCTION

Standards for grades of processed fruits and vegetables are designed, among other purposes, to serve as a convenient basis for sale in wholesale transactions and for the quality control programs of producers and processors. Distinctions between grades are made on the basis of such factors as flavor, odor, tenderness, color, size, and appearance. All of these criteria possess considerable face validity and undoubtedly reflect real qualitative differences in the commodities being graded.

Although official grading standards are developed by experts, based on industry practices, little information exists on consumer discrimination in relation to these grade classifications.

The purpose of this research was to determine the relationship between the grading standards prescribed for frozen peas and consumer satisfactions or dissatisfactions with the different grades. The results should be of interest to producers, processors, wholesalers, and officers of the Department responsible for establishing standards for grades.

Procedures

The research was conducted in 3 phases. In the first, samples of grades A, B, and C of Dark Green Perfection peas were subjected to standard physical and chemical tests to verify the accuracy of the grading. In the second, small panels of untrained taste testers were used to determine whether or not the three grades were mutually discriminable. In the final phase, preference ratings were obtained from a panel of consumer households. Further details on the procedures followed in each of these phases of the investigation are given in the body of the report.

CHEMICAL AND PHYSICAL MEASUREMENTS

In order to characterize the peas used in the investigation, the chemical and physical measurements most commonly used as indices of quality were made.

The methods of assay have been described in previous papers: Chlorophyll, reduced ascorbic acid and Hunter color-difference meter (5); total solids (6); alcohol insoluble solids (8); total sugars (1); peroxidase (7). 1/

The results are summarized in table 1. The peroxidase test showed that the peas were adequately blanched. Small percentage chlorophyll conversion and high ascorbic acid content indicate good handling and processing procedures. The values in the table are well within the limits found by the Western Regional Laboratory for 12 commercial packs where observers from the Laboratory were present at the time of processing to check the procedures. The chlorophyll conversion for the 12 lots varied from 2.6 to 7.5 percent, and the ascorbic acid content from 13.4 to 25.0 mg./100 g.

The Hunter-a/b values show that the grade A and B peas were yellower green than were grade C and the

$$\sqrt{a^2 + b^2}$$

values show that grade B peas had the most vivid, bright color; grade A, intermediate; and grade C the dullest or grayest green color. These differences are just large enough for trained judges consistently to distinguish between samples. The L values show that the grade C peas were considerably darker than were the other grades.

Total solids, alcohol insoluble solids, and total sugars content are indices of maturing. Table 1 shows that the grade A peas were considerably less mature than were peas of the other two grades. Although the objective values alone indicate that grade B and C peas were of similar maturity, the subjective results showed that the grade B were uniformly medium mature whereas the grade C lot was nonuniform in maturity; it was composed of small immature and large overmature peas.

1/ Underscored figures in parenthesis refer to section called References, page 10.

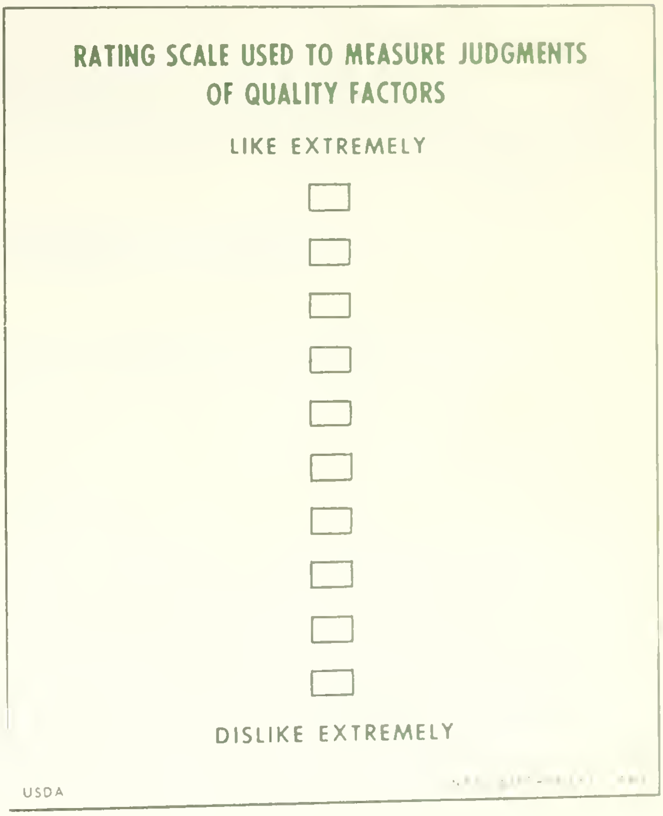
SMALL PANEL DISCRIMINATION AND PREFERENCE TESTS

The main purpose of the small panel tests was to determine whether the small group could distinguish between the grades. If they could not do so, the samples would not be suitable for the household consumer investigation. In addition to the discrimination tests, preferences of the small panel as regards the separate quality factors, flavor, tenderness, and color, were obtained.

Each grade of peas was cooked to optimum "doneness" for its maturity (grade A boiled 5 minutes; grades B and C, 11 minutes) and served to the panels with salt and butter.

The duo-trio test was used to determine whether the observers could distinguish between the grades. The observer received a labeled sample and 2 coded samples, one of which was a duplicate of the labeled sample and he was asked to indicate which coded sample was the duplicate. As supplementary information he was asked also to indicate which sample he preferred. Each pair (grades A-B, B-C, A-C) was appraised twice by 31 employees of the Laboratory who had never served on any taste panel.

A 10-point hedonic scale shown in figure 1 was used to obtain the panel members' judgments of the separate quality factors. In analyzing the results, the scale was scored from 1 for the lowest block to 10 at the top. A different package of peas was used for each quality factor. One week elapsed between ratings to minimize memory effects. The duo-trio tests were completed before starting the hedonic tests because a normal reaction to the sample as a whole was desired in the former.



RATING SCALE USED TO MEASURE JUDGMENTS
OF QUALITY FACTORS

LIKE EXTREMELY

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DISLIKE EXTREMELY

USDA

Figure 1

The data for observers who correctly matched duplicates in the duo-trio tests (table 2) show that a significant proportion of these inexperienced tasters could distinguish between all combinations of the three grades. Thus, the consumer tests could be undertaken with some degree of confidence that positive results would be found.

The preference results of the duo-trio tests (table 2) show that a significant number of observers preferred grade B to C and A to C. This was not the case for grades A and B. Although practically all of the panel members had shown that grades A and B were not alike, approximately an equal number preferred each of these grades.

Ratings obtained with the hedonic scale also indicated that the judges preferred the higher grades of peas. The mean preference scores for 3 quality factors are presented in the following tabulation:

	Grade A		Grade B		Grade C	
	Mean	N	Mean	N	Mean	N
Flavor ------	8.0	62	7.3	62	6.0	62
Color -------	7.5	62	7.1	62	5.5	62
Tenderness --	7.2	62	6.4	62	5.2	62

Thus it is shown that all factors of grade A peas are liked quite well and progressively lower grades were liked progressively less.

Of those persons who expressed a preference in the case of grades B-C and A-C, a significant number liked the higher grade better in all respects (table 2). In the comparison of grades A-B, however, flavor was the only factor for which there was a significant preference, grade A being the preferred sample.

CONSUMER PREFERENCE EXPERIMENT

The consumer preference phase of the study was conducted in the Oakland, Calif., metropolitan area in September and October 1957.

The Sample

A random sample of 25 clusters of households was drawn, and within each cluster 9 households were selected to participate in the experiment. All members of each household 16 years of age and over were considered eligible subjects. No households were included when (1) the dwelling unit lacked facilities for storing and cooking frozen food, (2) more than 1 nonfamily member took their meals with the family, (3) a language difficulty or educational handicap prevented the homemaker from understanding the instructions, or (4) the homemaker was unwilling to agree to test and rate all 3 grades of peas. Of the original 225 households, 214 participated throughout all stages of the experiment.

The Experimental Design

Each participating household was randomly assigned to a group which rated the 3 grades of peas in the orders indicated by the following diagram:

Order of rating each grade

	Group 1	2	3	4	5	6	7	8	9
1st week -	A	A	A	B	B	B	C	C	C
2nd week -	A	B	C	B	A	C	C	A	B
3rd week -	A	C	B	B	C	A	C	B	A

In this manner, each grade was rated in all possible sequences, and in 6 of the 9 groups of households all 3 grades were rated. The design also provides a measure of the reliability of the ratings, since in 3 groups the same grade was rated each week. A total of 930 ratings were obtained from households that rated all 3 grades, and 444 were obtained from households that rated the same grade each week.

The Rating Method

The single stimulus method was used to obtain the preference ratings. One grade was rated each week and subjects were asked to use the 10-point hedonic scale shown in figure 1 to indicate their judgment of the overall quality of the peas. The ratings were made immediately after the meal at which the peas were served. The instructions for use of the scale were as follows:

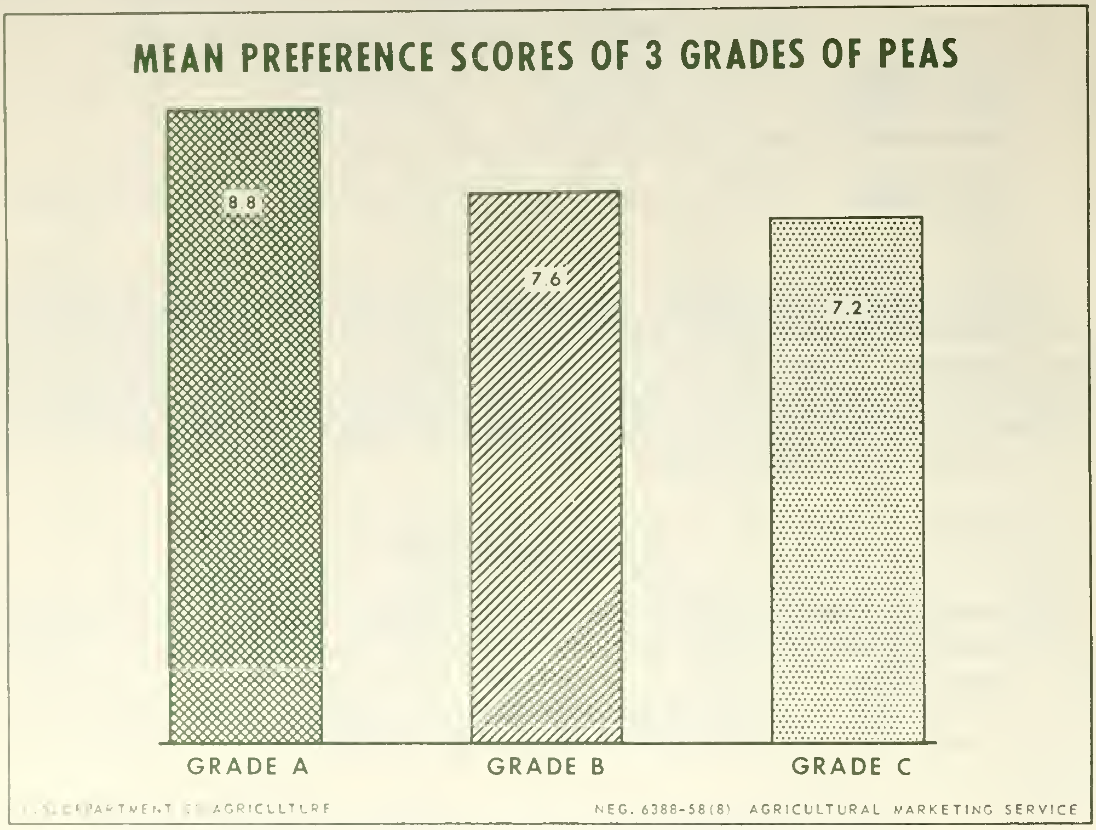
> "From the rating scale you will see that your opinion of these peas may be expressed anywhere from "Dislike Extremely" up to "Like Extremely." Put an "X" in the one block that best expresses your opinion of these peas."

The scores given each grade by all members of the same household were combined to obtain a mean preference score for the household.

In addition to the data obtained through use of the scale, interviews were conducted with each homemaker to obtain an explanation of the reasons for the scores assigned, and to obtain information on several background characteristics of the household. The subjects were given no indication that the experiment concerned their evaluations of different grades of peas.

The Results

Preference ratings.--The mean preference ratings of the overall quality of the 3 grades of peas are shown in figure 2. It is evident that as far as the peas used in this experiment are concerned, consumers do distinguish between grades and tend to prefer the higher grades.



MEAN PREFERENCE SCORES OF 3 GRADES OF PEAS

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Figure 2

The smaller difference between the mean scores for grades B and C compared with the difference between the mean scores for grades A and B is consistent with the results of the laboratory tests which showed a mixture of small immature and large overmature peas, rather than a homogeneous lot of peas of the lowest grade (table 3).

Further analysis of the results of the experiment shows that there was significant variation between ratings made in different households, between the three stages of the experiment, and between groups that rated the grades in different orders (table 3).

The differences between household means reflect a range of mean household scores for grades A and B from about 2 up to 10 and for grade C from less than 1 up to 10. These wide ranges are due in part to the fact that the rating scale is relatively unstructured, and the absolute value of a score, consequently, has a different meaning for each subject. The differences may also be due to preferences unrelated to grade. About 10 percent of the homemakers in this experiment like canned peas better than fresh or frozen peas and 30 percent usually buy canned peas. It is possible that even the best of frozen peas do not appeal as strongly to homemakers who ordinarily use canned peas as they do to homemakers who use frozen peas.

The variation between stages resulted from an average decline in the rating of all grades of .3 of a scale point between the first and second and between the second and third stages of the experiment.

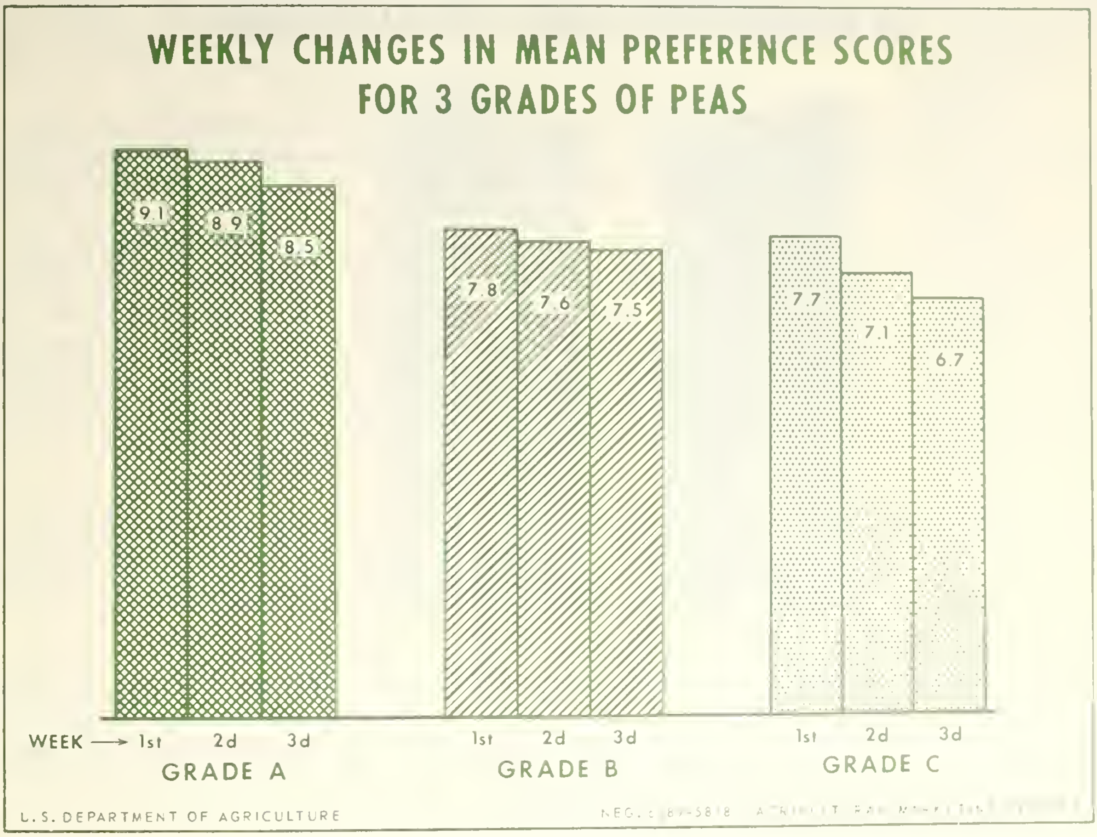

Figure 3

The largest part of the difference between stages was due to the fact that the mean scores for grade C peas declined a full scale point between the first and third stages of the experiment compared with .6 of a scale point for grade A and .3 of a scale point for grade B. It is evident that subjects tended to grow more critical with increasing experience in appraising the quality of the peas. These changes are shown in figure 3.

Variation in the mean scores was also affected by the order in which the grades were rated. This is to be expected since, when data are obtained by the single stimulus method, the series tends to form the standard or norm in terms of which of the various grades are rated. The influence of order is shown in figure 4 which compares the mean score of each grade when it was rated after the other 2 grades with the expected score. The expected score was obtained by subtracting the average change between stages from the mean score of the immediately preceding stage, and the ratio of the expected score to the received score is used to show the changes produced by experience with other grades apart from the changes that occurred between stages.

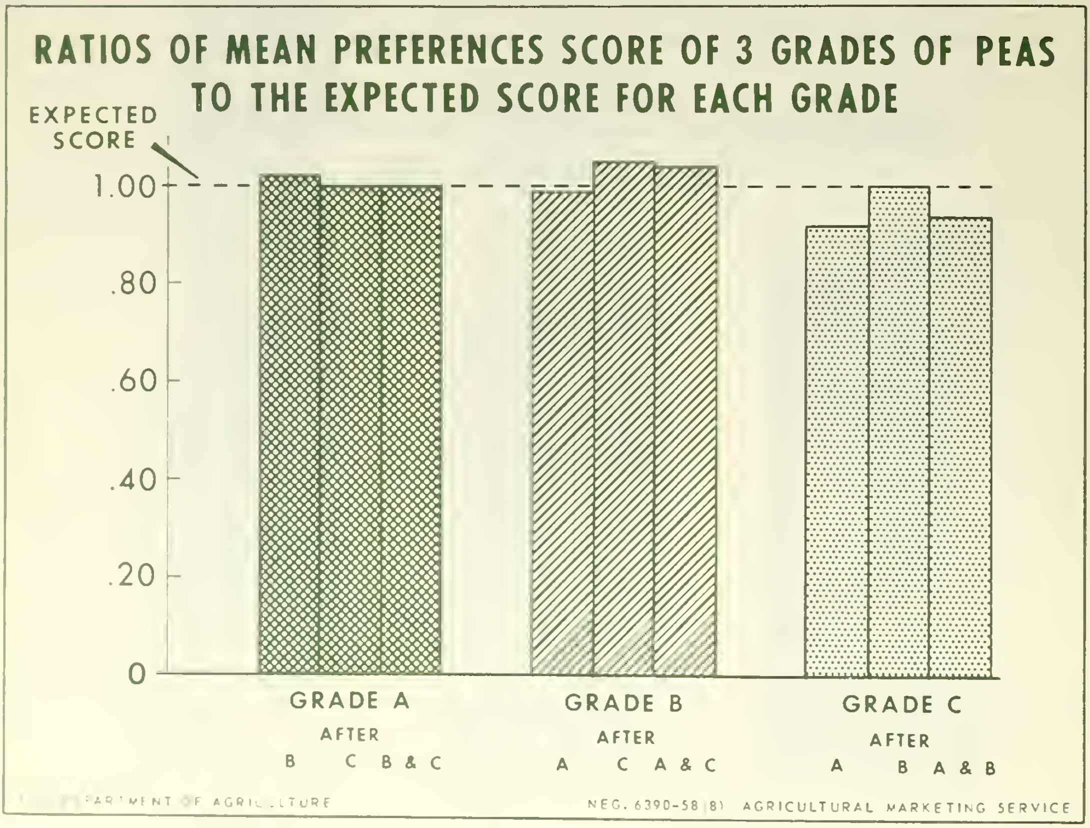

Figure 4

The rating of grade A peas was least affected by the order of the ratings; regardless of order, mean scores for this grade were the same or practically the same as the expected score. The ratings given grade B were uninfluenced by experience with grade A but were higher than expected when rated after grade C or both A and C. Finally, mean scores for grade C were at the expected level when rated after grade B but were lower than expected when rated after grade A or both grade A and B.

Reasons for preferences.--At the time the preference scores were collected each week homemakers were asked, "What was it about the peas I left last week that made you decide to give them the rating that you did?" Respondents were given no indication of the terms in which the question should be answered, but the replies were classified on the basis of the criteria used in grading frozen peas which consumers might be expected to note while eating them. This system of classification contained the following categories: (1) taste, (2) tenderness, (3) color, (4) size, (5) appearance, (6) presence or absence of defects, (7) presence or absence of foreign matter, (8) no reference to a standard for grades, (9) no favorable reasons, and (10) no unfavorable reasons.

The two most important characteristics influencing favorable ratings of all 3 grades were taste and tenderness. These 2 characteristics were also the basis for distinction between grades. Eighty-two percent of the respondents mentioned taste in explaining their ratings of grade A compared with 73 and 68 percent who spoke favorably of the taste of grades B and C; 55 percent mentioned the tenderness of grade A peas whereas just 39 and 30 percent spoke favorably of the tenderness of grades B and C.

The only other grading criteria mentioned by as many as 10 percent of the respondents were color and size, and about the same proportions of respondents made favorable references to these characteristics of all 3 grades.

Unfavorable ratings were caused chiefly by negative reactions to the tenderness, size, and taste of the peas. Of these, reactions to tenderness and taste were the basis for grade preferences. Eighteen percent of the respondents were dissatisfied with the tenderness of grade A; about twice this proportion were dissatisfied with this characteristic of grades B and C. Ten percent of the respondents were dissatisfied with the taste of grade A, and again, about twice as many respondents criticized this characteristic of grades B and C.

It should also be noted that 74 percent of the respondents were completely favorable in their reactions to grade A, whereas 53 percent were uncritical of grade B and 47 percent were uncritical of grade C (table 4).

In the discussion of preference ratings it was noted that mean scores tended to decline as the subjects became more experienced in appraising the qualities of different grades of peas. This tendency is also apparent in the respondents' explanations of the reasons for their ratings. In the last interview with respondents, after all three grades had been rated, the proportion who made favorable references to the color of grade A peas was somewhat smaller than it was before the other grades had been rated and fewer of the respondents had no criticisms at all. On the last interview the proportions who spoke favorably of the taste of grades B and C were smaller, and the proportions who were critical of the tenderness, size, and taste, of grade C were larger than on earlier interviews.

The most notable change, however, was in the proportions who had no unfavorable comments to make about grade C; on the first interview 77 percent made only favorable remarks about peas of this grade. On the second interview this proportion had declined to 49 percent, and on the last, it had dropped to 34 percent (tables 5, 6, and 7).

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APPENDIX

Reliability of Preference Ratings

In the design of this experiment provision was made for each grade to be rated in the same households for 3 successive weeks. The subjects, however, were not told that they were being asked to rate identical grades. The purpose of this provision was to obtain information on the reliability of the preference ratings, that is, to find out whether or not they were stable, reproduceable expressions of the respondents' opinions of the qualities of each grade.

The only significant variation found in the analysis of the preference ratings of these subjects was that between households. No significant changes occurred during the course of the experiment. Preference ratings for grades, though in the correct rank order, were not significantly different (table 8).

Characteristics of the Subjects

The subjects who participated in this experiment represented a wide range of income, age, and educational levels; white and nonwhite households were included. The following tabulation shows the distribution of these characteristics in the sample:

	Percent
Family income level	
Upper ($6,000 and over)	31
Middle ($3,000 to $5,999)	43
Lower (Under $3,000)	26
Number of households 1/	180
Age of homemaker	
51 and over	32
36 to 50	32
Under 35	34
Not ascertained	2
Number of homemakers	224
Homemaker's formal education	
College	21
High school	55
Grammar school and none	24
Number of homemakers	224
Race of homemakers	
White	68
Nonwhite	32
Number of homemakers	224

1/ Income was not ascertained for 44 respondents.

The subjects also differed in their preferences for and their customary use of different forms of peas:

	Percent
Form of peas preferred	
Prefer frozen	68
Prefer fresh	22
Prefer canned	9
No preference	1
Number of homemakers	224
Form of peas usually bought	
Frozen	66
Canned	31
Fresh	3
Number of homemakers	224
Frequency of use of peas in the 2 weeks preceding the first interview	
3 or more times	22
Once or twice	55
Not at all	12
Not ascertained	1
Number of homemakers	224

Tables

Table 1.--Chemical and physical tests

Test	Grade of peas		
	A	B	C
	Percent	Percent	Percent
Chlorophyll conversion	4.2	4.0	4.5
Reduced ascorbic acid - mg./100g.	21.6	17.1	17.8
Total solids	18.6	23.6	23.6
Alcohol insoluble solids	10.4	16.1	16.4
Total sugars	5.2	4.9	4.6
Peroxidase	negative	negative	negative
Hunter color-difference meter 1/			
L	39.5	39.9	36.6
-a	19.2	20.0	19.1
b	17.3	17.8	16.2
-a/b	1.11	1.12	1.18
$\sqrt{a^2 + b^2}$	25.9	26.7	25.1

1/ Smaller L, -a/b, and $\sqrt{a^2+b^2}$ values indicate darker, yellower, and duller or less vivid green color respectively.

Table 2.--Discrimination and preference tests by small panel

Test	Grades being compared 1/		
	A - B	B - C	A - C
	Percent	Percent	Percent
Duo-trio: Correctly matched duplicates 2/ ---------------	95*	69*	84*
Duo-trio: Preferred higher grade of pair ----------------	46	71*	63*
Hedonic: Flavor--higher grade liked better 3/ -------------	64*	70*	76*
Hedonic: Tenderness--higher grade liked better 3/ -------	58	64*	72*
Hedonic: Color--higher grade liked better 3/ -------------	56	67*	73*

1/ Asterisk indicates significance at 5-percent level or better by Chi-square.
2/ 62 total judgments.
3/ Judgments showing no preference omitted (11 to 16 percent of cases except for color of grades B-C with 22 percent).

Table 3.--Analysis of variance of ratings of 3 grades of frozen peas by 6 groups of subjects who rated the grades in different orders

Source	Degrees of freedom	Sums of squares	Mean square	F
Total	425	2,364.15	--	--
Grades (including order)	2	201.04	100.52	26.81**
Households ------------	141	1,061.12	7.53	2.01**
Time ------------------	2	32.62	16.32	4.35*
Order (excluding grade)	2	27.27	13.64	3.64*
Residual --------------	278	1,042.10	3.75	--

** Significant at the .01-percent level.
* Significant at the .05-percent level.

Table 4.--Classification of favorable replies to the question, "What was it about the peas I left last week that made you decide to give them the rating that you did?" by grade

Classification	Homemakers who rated		
	Grade A	Grade B	Grade C
	Percent [1]	Percent [1]	Percent [1]
Favorable			
Taste	82	73	68
Tenderness	55	39	30
Color	17	15	17
Size	13	15	14
Appearance	1	4	1
Defects	[2] *	*	--
Miscellaneous	*	--	--
No reference to a standard for grade	5	6	8
No favorable reasons	3	9	14
Unfavorable			
Tenderness	18	30	36
Size	13	21	14
Taste	10	20	23
Appearance	3	4	1
Color	1	1	3
Defects	*	--	--
Foreign matter	*	1	1
No reference to a standard for grade	*	2	2
Miscellaneous	--	--	*
No unfavorable reasons	74	53	47
Number of homemakers [3]	216	217	221

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[1] Percentages add to more than 100 because some homemakers gave more than one reason.

[2] Asterisk denotes less than 1 percent.

[3] Reasons for the ratings were not ascertained for a few respondents.

Table 5.--Classification of replies to the question, "What was it about the peas I left last week that made you decide to give them the ratings that you did?" by time of interview

Classification	Homemakers who rated Grade A		
	First week	Second week	Third week
	Percent 1/	Percent 1/	Percent 1/
Favorable			
Taste	85	85	77
Tenderness	58	54	52
Color	28	10	14
Size	7	14	16
Appearance	4	--	--
Defects	--	1	--
Miscellaneous	1	--	--
No reference to a standard for grade	4	4	5
No favorable reasons	4	4	5
Unfavorable			
Tenderness	10	8	11
Size	7	11	21
Taste	7	10	14
Appearance	3	3	3
Color	1	--	1
Defects	--	--	--
Foreign matter	--	1	--
No reference to a standard for grade	--	1	--
Miscellaneous	--	--	--
No unfavorable reasons	79	75	68
Number of homemakers 2/	72	72	73

1/ Percentages add to more than 100 because some homemakers gave more than one reason.

2/ Reasons for the ratings were not ascertained for a few respondents.

Table 6.--Classification of replies to the question, "What was it about the peas I left last week that made you decide to give them the rating that you did?" by time of interview

Classification	Homemakers who rated Grade B		
	First week	Second week	Third week
	Percent 1/	Percent 1/	Percent 1/
Favorable			
Taste	82	67	70
Tenderness	43	36	36
Color	15	15	14
Size	17	14	13
Appearance	4	6	--
Defects	--	1	--
Miscellaneous	--	--	--
No reference to a standard for grade	3	7	10
No favorable reasons	7	10	10
Unfavorable			
Tenderness	28	33	29
Size	21	22	19
Taste	16	24	21
Appearance	4	4	2
Color	3	--	--
Defects	--	1	--
Foreign matter	3	1	--
No reference to a standard for grade	1	3	1
Miscellaneous	--	--	--
No unfavorable reasons	51	53	54
Number of homemakers 2/	75	72	70

1/ Percentages add to more than 100 because some homemakers gave more than one reason.

2/ Reasons for the ratings were not ascertained for a few respondents.

Table 7.--Classification of replies to the question, "What was it about the peas I left last week that made you decide to give them the rating that you did?" by time of interview

Classification	Homemakers who rated Grade C		
	First week	Second week	Third week
	Percent 1/	Percent 1/	Percent 1/
Favorable			
Taste	82	61	62
Tenderness	31	35	23
Color	23	12	15
Size	9	15	16
Appearance	3	--	--
Defects	--	--	--
Miscellaneous	--	--	--
No reference to a standard for grade	4	11	8
No favorable reasons	8	18	15
Unfavorable			
Tenderness	9	39	49
Size	7	16	14
Taste	7	27	30
Appearance	3	1	--
Color	1	1	5
Defects	--	--	--
Foreign matter	--	1	1
No reference to a standard for grade	--	3	3
Miscellaneous	--	--	1
No unfavorable reasons	77	49	34
Number of homemakers 2/	74	74	73

1/ Percentages add to more than 100 because some homemakers gave more than one reason.

2/ Reasons for the ratings were not ascertained for a few respondents.

Table 8.--Analysis of variance of 3 grades of frozen peas by subjects who rated the same grade 3 times

Source	Degrees of freedom	Sums of squares	Mean square	F
Total ----------------	215	1,042.84	--	--
Grades --------------	2	6.78	3.39	1.32
Time ----------------	2	2.90	1.45	1.76
Households -----------	71	674.84	9.50	3.71*
Residual -------------	140	358.32	2.56	--

* Significant at the 5-percent level.

*U. S. GOVERNMENT PRINTING OFFICE [illegible]